Freeman Ground Water Contamination
Freeman, Washington

Preliminary Assessment

April 2013

Prepared for:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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List of Abbreviations and Acronyms

bgs	Below Ground Surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
E & E	Ecology and Environment, Inc.
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
gpm	Gallons per Minute
HDPE	High-Density Polyethylene
MCL	Maximum Contaminant Level
NPDES	National Pollutant Discharge Elimination System
PA	Preliminary Assessment
START	Superfund Technical Assessment and Response Team
TDL	Target Distance Limit
UPRR	Union Pacific Railroad
USDA	United States Department of Agriculture
UST	Underground Storage Tank
VOC	Volatile Organic Compound
WAC	Washington Administrative Code
WDOH	Washington State Department of Health
µg/L	Micrograms per Liter

1 Introduction

Ecology and Environment, Inc. (E & E) was tasked by the United States Environmental Protection Agency (EPA) to provide technical support for completion of a Preliminary Assessment (PA) at the Freeman Ground Water Contamination site in Freeman, Washington. E & E completed PA activities under Technical Direction Document Number 12-11-0007, issued under EPA, Region 10, Superfund Technical Assessment and Response Team (START)-3 Contract No. EP-S7-06-02. The PA was conducted under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986.

The PA is the first phase in the process of determining whether a site is releasing, or has the potential to release, hazardous substances, pollutants, or contaminants into the environment and whether it requires additional investigation and/or response action that is authorized by CERCLA. The assessment process does not include extensive or complete site characterization, contaminant fate determination, or quantitative risk assessment.

The specific goals for the Freeman Ground Water Contamination PA, identified by the EPA, are to:

- Determine the potential threat to public health or the environment posed by the site;
- Determine the potential for a release of hazardous constituents into the environment; and
- Determine the potential for placement of the site on the National Priorities List.

Completion of the PA included reviewing existing site information, collecting receptor information within the range of site influence, and determining regional characteristics. This document includes a discussion of background site information (Section 2), a discussion of the ground water migration pathway and potential receptors (targets; Section 3), a summary of site conditions and a discussion of conclusions (Section 4), and a list of pertinent references (Section 5).

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2 Site Background

2.1 Site Location

Site Name:	Freeman Ground Water Contamination
CERCLIS ID Number:	WAN001003081
Site Address:	No Street Address Freeman, WA 99015
Latitude:	47^{o} 31’ 10.30” ((b) (6) Well)
Longitude:	-117^{o} 11’ 39.47” ((b) (6) Well)
Legal Description:	Township 23 North, Range 44 East, Section 1
County:	Spokane
Congressional District:	5

2.2 Site Description

The Freeman Ground Water Contamination site is a carbon tetrachloride ground water plume located in Freeman, Washington, a rural town in Spokane County (Figure 2-1). Carbon tetrachloride has been detected in samples collected from the Freeman School District water supply well since January 2001. At present, a source for this contamination has not been identified.

The land surface in the area of the plume is at an approximate elevation of between 2,590 to 2,610 feet above mean sea level. The town of Freeman has few residences and is dominated by the Freeman School District campus (Figure 2-2). The Freeman Store is present on the north end of town (See Appendix A for images). An active Cenex Harvest States store with eleven steel grain silos/bins and one steel grain elevator is present between State Highway 27 and a Union Pacific Railroad (UPRR) line which roughly parallels the highway (See Appendix A for Cenex Harvest States image; formerly Rockford Grain Growers). A former clay borrow pit is located approximately 0.5 mile northeast of the former Cenex Harvest States store, and a former brick kiln is present on the southeastern end of town. Beyond these uses, land near Freeman is primarily used for agricultural production.

The Freeman School District school campus contains a high school, middle school, and elementary school on approximately 52 acres of land. North/south trending Jackson Road splits the property. The elementary school, middle school, and the primary drinking water well for the campus are on the eastern portion of the parcel; while the high school, sports field, running track, drinking water storage tanks, and sanitary waste water lagoons (Lake Lally) are on the western portion of the parcel (Figure 2-2).

2.3 Ground Water Contamination

In January 2001, carbon tetrachloride was detected at 0.7 micrograms per liter (μg/L) in a well operated by the Freeman School District. This well is used as the sole source of potable water to the Freeman School Campus. In April 2008, continued monitoring of this well revealed the presence of carbon tetrachloride at a concentration of 7.78 μg/L, exceeding the EPA Safe Drinking Water Act Maximum Contaminant Level (MCL) of 5 μg/L. Since that date, this MCL has been exceeded on three additional occasions: in March 2012, with a concentration of 5.9 μg/L; in April 2012, with a concentration of 7.2 μg/L; and in December 2012, with a concentration of 8.0 μg/L. All sample results for this well from 1992 to 2012 are provided in Table 2-1. (Leinart 2012; WDOH 2013)

In May 2012, the Freeman School District analyzed water from a former residential well on property that had been acquired by the school district in anticipation of a campus expansion program. This well, referred to as the “(b) (6) well, was sampled by the school district to determine whether the well could be used to supplement the district’s water supply. The (b) (6) well is located approximately 0.25 mile north of the school district well and is at an elevation that is approximately 25 feet higher than the school district well (Figure 2-2). Water from the (b) (6) well contained carbon tetrachloride at 48.1 μg/L. The former (b) (6) house and associated out-buildings have been demolished. (Leinart 2012)

In February 2013, GeoEngineers, Inc. completed a draft feasibility study for the Freeman School District to identify and prioritize alternatives for mitigating observed carbon tetrachloride contamination present in the district’s primary drinking water well. The study included sampling of several ground water wells, a discussion of which is included in Section 2.6.4 below.

2.4 Carbon Tetrachloride Characteristics

Carbon tetrachloride is a manufactured chemical that does not occur naturally. This clear liquid evaporates easily and has a sweet smell that can be detected at low levels (i.e., 10 parts per million in air). It is not known whether people can taste carbon tetrachloride, and if so, at what level. Synonyms for this chemical include carbon chloride, methane tetrachloride, perchloromethane, tetrachloroethane, and benziform (ATSDR 2005).

Upon entering the environment, carbon tetrachloride volatilizes quickly in the air, where it can remain for several years before breaking down into its degradation products. Carbon tetrachloride does not easily adhere to soil particles; instead, the chemical either evaporates into the air or enters the soil and/or ground water (Misiorowski and Eagle 2007). Carbon tetrachloride generally does not easily dissolve in water and, at normal temperature and pressure, this chemical is denser than water (Misiorowski and Eagle 2007; ATSDR 2005). Carbon tetrachloride is a stable chemical that degrades very slowly; therefore, as a consequence of releases from human activities, a gradual accumulation of carbon tetrachloride has occurred in the environment (ATSDR 2005). When carbon tetrachloride enters the ground water, this chemical will migrate downward until it encounters a geologic barrier that prevents further vertical transport. At this point, the chemical will continue to break down at a slow rate, and may persist in various constituent forms for many years, decades, or longer (Misiorowski and Eagle 2007).

2.5 Uses of Carbon Tetrachloride

Carbon tetrachloride is a multi-purpose chemical used as a degreasing solvent for industrial and domestic purposes, a fire suppressant, a cleaning agent for dry cleaning, in making nylon, and, for many years, as a fumigant in grain operations throughout the Midwest (Misiorowski and Eagle 2007). Due to its toxicity, most of these uses were discontinued in the mid-1960s (ATSDR 2005).

In 1911, carbon tetrachloride was recommended as a substitute insecticide for carbon disulfide and, by the end of World War I, better equipment and technology increased its use as an insecticide and pesticide (Misiorowski and Eagle 2007). Carbon tetrachloride became the most widely used liquid fumigant to kill insects in grain until 1986, when its use for this purpose was cancelled by the EPA (ATSDR 2005; DHHS 2011; Storey et. al. 1981). Until 1986, the largest source of carbon tetrachloride releases to the environment were from its use as a grain fumigant. It has been estimated that 28 million pounds of carbon tetrachloride were used as a fumigant in 1978 (ATSDR 2005).

A mixture containing a 1:4 ratio of carbon disulfide and carbon tetrachloride, commonly known as 80:20 or 80-20 fumigant, had been used to fumigate grain (Storey et. al. 1981). Some formulations of 80-20 fumigant may also have contained a minor amount of ethylene dibromide, also known as 1,2-dibromoethane. A degradation product of carbon tetrachloride is chloroform (EPA 2010). The 80-20 formulation was developed to reduce the flammability and explosive hazards of straight carbon disulfide. In grain elevator storage, the formulation was generally applied during bin loading with a layering method in which it was pumped or poured over the grain between drafts from 10 to 20 feet deep (Storey et. al. 1981).

Carbon tetrachloride has been known to enter the environment due to fumigation or direct application of the 80-20 mixture and by its use in grain elevator boots to control rodents and pests. This chemical also was applied directly on the ground at gopher holes and around building foundations to kill mice, rats, and other pests. Unintended releases of carbon tetrachloride have occurred via spills and leaks from various transporting devices and equipment, such as rail cars, delivery trucks, leaky hoses, and onsite storage tanks, and the improper disposal of excess product by simply pouring it on the ground. (Misiorowski and Eagle 2007)

EPA Region 7, in conjunction with the United States Department of Agriculture (USDA), has conducted studies at grain storage sites in four states (Nebraska, Kansas, Missouri, and Iowa). As of 2007, the USDA had tested 829 facilities, and 130 of those facilities had detections of carbon tetrachloride in the water samples. In fact, at 47 percent of the positively detected locations, the carbon tetrachloride concentrations were above the EPA MCL. (Misiorowski and Eagle 2007)

As an example, the Garvey Elevator Superfund Site in Hastings, Nebraska had releases of carbon tetrachloride to the environment from breaks in distribution lines running between a large-capacity aboveground 80-20 fumigant storage tank and grain silos. The releases at this facility resulted in carbon tetrachloride soil contamination as well as a 3-mile long ground water plume. At this particular facility, carbon tetrachloride in ground water was detected at concentrations up to 29,943 μg/L in a sample collected from a monitoring well near the grain elevator. Further, carbon tetrachloride was found to be present in soil gas within the unsaturated zone (i.e., above the water table) across approximately one-third of the 22-acre active portion of the site. Carbon tetrachloride was also detected in a City of Hastings municipal well, located approximately 1,500 feet from the Garvey Elevator Superfund Site, at a concentration of 5 μg/L. The ground water surface in the area of this site (i.e., static water level) was approximately 115 feet below ground surface (bgs), demonstrating the depths that carbon tetrachloride had migrated through the soil column (EPA 2010).

Carbon tetrachloride was not only used at commercial grain storage operations; during its height, 80-20 was also a primary fumigant for all types and sizes of privately-owned farms throughout the country (Misiorowski and Eagle 2007).

2.6 Previous Investigations

Since the discovery of carbon tetrachloride in ground water in the Freeman School District well, several investigations have taken place to identify a likely source(s) of this contamination. These investigations did not include environmental sampling. In addition, one study was conducted to recommend a means of supplying uncontaminated water to the Freeman School District campus. This study included sampling of several ground water wells. Each investigation/study is discussed below.

2.6.1 Washington State Department of Health, Technical Assessment 2008

In May 2008, the Washington State Department of Health (WDOH) completed a Technical Assistance Consultation concerning the potential health hazards posed by the presence of carbon tetrachloride in the Freeman School District drinking water. The consultation was conducted in response to a notification by the Freeman School District to the WDOH that carbon tetrachloride had been detected in their well at a concentration that exceeded the MCL. For the consultation, the WDOH determined that the concentrations of carbon tetrachloride present in this water would not result in any non-cancer adverse health effects, and that the estimated cancer risk ranged from insignificant to very low. Based on these findings, the WDOH concluded that no apparent public health hazard existed for students, teachers, and other employees exposed to carbon tetrachloride present in Freeman School District drinking water. (O'Garro 2008)

2.6.2 Washington State Department of Ecology, Summary Report 2012

In August 2012, the Washington State Department of Ecology (Ecology) completed a report summarizing the history of known carbon tetrachloride ground water contamination in the city of Freeman (Leinart 2012). This report also identified businesses and features that were considered potential sources for this contamination. The report categorized the likelihood of each feature being a source from high to low. These features, and their presumed likelihood of being a source of contamination, are as follows (Leinart 2012):

- **High Likelihood –**
  - Cenex Harvest States, Freeman (formerly known as Rockford Grain Growers) has a grain storage facility located approximately 250 feet northeast of the (b) (6) well.
- **Medium Likelihood –**
  - UPRR has a main line and a rail siding located approximately 300 feet east of the (b) (6) well.
  - The abandoned Old Freeman Clay Pit is located approximately 0.15 mile northeast of the (b) (6) well and may have been used for illegal dumping or disposal of carbon tetrachloride.
  - Freeman School District facilities may have historically used carbon tetrachloride in welding/metal fabrication and automotive workshops, the school bus service/maintenance shop, and/or laboratory classrooms.
- **Low Likelihood –**
  - Freeman School District underground storage tanks (USTs).
  - Freeman School District surface water outfall.
  - Freeman Store automotive gasoline service station UST.
  - Former brick kiln.
  - State Route 27.
  - Former shops and out-buildings at the (b) (6) residence.

Features assigned a high or medium likelihood were those that are known to be associated with the use of carbon tetrachloride, those with a reasonable opportunity for improper waste disposal or storage practices, and/or those of sufficient scale to have possibly caused either a large release of carbon tetrachloride or ongoing small releases. Features assigned a low likelihood were those that were small in scale and that would not ordinarily use, store, or dispose carbon tetrachloride in a manner, or in the quantities, that could result in regional aquifer contamination. At the time of this report, no specific data or information had yet been uncovered by Ecology documenting the use, storage, or disposal of carbon tetrachloride in the Freeman area. (Leinart 2012)

2.6.3 GeoEngineers, Inc., Feasibility Evaluation, Production Well Evaluation – Carbon Tetrachloride Contamination 2013

In February 2013, GeoEngineers, Inc. completed a draft feasibility study for the Freeman School District that evaluated alternatives for addressing carbon tetrachloride contamination present in the district's primary drinking water well (termed a production well in the report). For the study, five wells were sampled (Figure 2-3). These included the school district's primary drinking water supply well, the (b) (6) [redacted] well (well W26), a former domestic well located in the southeast portion of the Freeman School District campus ((b) (6) [redacted] well W20), a private well located southeast of the campus ((b) (6) [redacted] well W30), and the Freeman Store well. Only two of these wells contained detectable concentrations of volatile organic compounds (VOCs). These were the school district's primary drinking water supply well and the (b) (6) [redacted] well (W20). In these wells, carbon tetrachloride was present at 22.0 and 21.2 μg/L, respectively. Additionally, chloroform was present in these two wells at 1.28 and 2.04 μg/L, respectively. No other VOCs were detected. Neither carbon tetrachloride nor chloroform were present in the remaining three wells at concentrations above the method reporting limit of 1 μg/L (including the (b) (6) [redacted] well which previously had a detection of carbon tetrachloride above the MCL in May 2012). GeoEngineers, Inc. speculated that the difference in carbon tetrachloride concentrations in the (b) (6) [redacted] well between the May 2012 sampling and the sampling in January 2013 may have been the result of differences in sampling techniques (such as purging the well before sampling), the depth of the water sampled within the well, the season sampling occurred, or plume migration. (GeoEngineers 2013)

The feasibility study explored three basic alternatives:

1. Providing an alternative water supply source;

2. Altering the design of the current water supply well to isolate the contaminated water zone from deeper uncontaminated water and draw water from that deeper zone; and

3. Treating water from the existing water supply well. (GeoEngineers 2013)

Of these alternatives, installing a new water supply well was recommended due to lower costs as compared to the other alternatives (GeoEngineers 2013).

2.7 Freeman School District Sanitary Waste Water Treatment System

The Freeman School District operates a sanitary waste water treatment system to manage waste water from the school campus under National Pollutant Discharge Elimination System (NPDES) permit number WA004540-3. The treatment facility was built in 1996 and consists of an aerated lagoon, a facultative lagoon, a chlorine disinfection basin, and four subsurface flow-type constructed wetlands. Both lagoons are lined with 60 mil high-density polyethylene (HDPE) liners. Waste water is stored in the lagoons for most of the school year (fall, winter and spring). After the students leave for summer break, the waste water is manually released via a single surface water outfall to the constructed wetlands located approximately 1,000 feet to the southeast in a manner that keeps the wetland plants alive until the students come back in the fall. Two wetlands were originally designed (western and eastern) (Figure 2-2), but only the eastern wetland is in use. (Nichols 2012)

The school district has not chlorinated since the treatment system went online in 1996 because fecal coliform counts at the wetlands have been historically low. Outflow from the constructed wetlands is to a natural drainage channel that flows seasonally and becomes a ditch that runs south along Jackson Road (Figure 2-2). This ditch meets Little Cottonwood Creek and is part of its head waters. Little Cottonwood Creek discharges into Rock Creek (Figure 2-1) which is a tributary of Hangman Creek. Hangman Creek is a tributary of the Spokane River. (Nichols 2012)

Sediment solids are periodically removed from the sanitary waste water lagoons. These solids are disposed as per the school district's biosolids permit BA004540-3, issued by Ecology. (Nichols 2012)

The NPDES permit has required effluent monitoring for biological oxygen demand, total suspended solids, fecal coliforms, and pH, and a one-time sampling requirement for select metals (cadmium, chromium, copper, lead, mercury, and zinc). Monitoring data indicate that the permit limits for these parameters are generally met, and are only infrequently exceeded. Additional requirements for monitoring waste water treatment system effluent will begin in 2014. These will be for the following parameters: dissolved oxygen, total phosphorus, total Kjeldahl nitrogen, ammonia, nitrate, and temperature. The school district has not been required to monitor effluent for chlorinated compounds since these contaminants, as well as other possible contaminants, are not expected to be present (Nichols 2012).

In 2008, approximately 20 tears/punctures along the perimeters, or edges, of the waste water lagoons HDPE liners were repaired. The current NPDES permit has a requirement for a comprehensive leak detection survey of the liners in 2017, the last year of the permit. (Nichols 2012)

Storm water on campus is not directed to the sanitary waste water treatment system. Instead, this water either infiltrates the ground or gravity flows to swales (Lally 2013).

Due to the construction parameters of the sanitary waste water treatment system, it appears to be an unlikely source of carbon tetrachloride contamination.

2.8 Underground Storage Tanks

Current and former USTs in Freeman area were documented to include the following:

- **Freeman School District –** A total of six current or former USTs, including:
  - Two 10,000-gallon heating fuel tanks installed in 1964 and removed in 1996 (Tank IDs #9360 and #9784) (Ecology 2013a).
  - One 2,000-gallon leaded gasoline tank installed in 1957 and removed in 1995 (Tank ID #33964) (Ecology 2013a). Approximately 37 tons of petroleum contaminated soil were removed from around the tank and disposed at a municipal landfill. The tank was in good condition when removed. Soil contamination was suspected of being due to a leaking fuel dispenser or from activities associated with fueling vehicles (BRA 1995).
  - One 12,000-gallon diesel tank installed in 1997 and removed in 2007 (Tank ID #5314) (Ecology 2013a). Petroleum-contaminated soil also was associated with this tank. Again, because the tank itself was in good condition, soil contamination was suspected of being due to a leaking fuel dispenser or from activities associated with fueling vehicles (Ecology 2007).
  - One new two compartment tank (Tank ID #619569) with one 12,000-gallon diesel compartment and one 3,000-gallon compartment for other petroleum substances. This tank was installed in 2007 adjacent to the Tank #5314 excavation. This tank is still in use (Ecology 2013a).
- **Freeman Store (a/k/a Freemen Enterprises Northwest, LLC) –** Two former sets and one new set of USTs, as follows:
  - Older removed USTs with no known date of installation or date of removal (Tank IDs not known) (Rob's Demolition 1998).
  - Two 3,000-gallon gasoline tanks (one leaded and one unleaded; Tank IDs not known) that were removed installed in 1981 and removed in 1998 (Ecology 2013a). The tanks were slightly to moderately corroded, but free

of holes at the time of removal. Soil around the tank fill sites was stained and had a petroleum odor. Some of this soil was excavated and stockpiled onsite (Rob's Demolition 1998). The final outcome of this soil was not discussed; however, on August 30, 2011, Ecology issued a No Further Action letter regarding this removal action (Ecology 2011).

- One operational three compartment UST (Tank ID 100547) installed in 1998. The compartments consist of 6,000-gallon unleaded gasoline compartment, one 10,000-gallon unleaded gasoline compartment, and one 6,000-gallon diesel compartment (Ecology 2013a).

As outlined above, all of the Freeman area USTs are associated with petroleum products. None were found to be associated with fumigant products or carbon tetrachloride.

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3 Ground Water Migration Pathway

The following sections describe the ground water migration pathway and potential targets within the site's range of influence (Figures 3-1). The surface water migration pathway, soil exposure pathway, and air migration pathway have not been included in this PA since, at present, the site consists of a ground water plume with no identified source.

3.1 Ground Water Migration Pathway

The target distance limit (TDL) for the ground water migration pathway is a 4-mile radius that extends from the estimated center of the ground water plume. Figure 3-1 depicts the ground water 4-mile TDL.

3.1.1 Geologic Setting

The town of Freeman is in the Columbia Plateaus physiographic province. The Columbia Plateau is underlain by nearly horizontal lava sheets of Columbia River Basalt of Tertiary age. Locally, the basalt flows are interbedded with sedimentary material of the Latah Formation. Both the basalt and the Latah Formation are overlain by the Palouse Formation of Quaternary age. Aeolian silts and clays of the Palouse Formation in the Freeman area range in thickness from 10 to 50 feet. The Latah Formation is sedimentary material interbedded with basalt flows, and primarily consists of clay and shale and some beds of sand and gravel. (USGS 1969)

3.1.2 Aquifer System

General ground water conditions have been described across the entirety of the Columbia Plateau. The Columbia Plateau aquifer system includes, from youngest to oldest: (1) the overburden, a collective term used in this study for all materials overlying the Columbia River Basalt Group; (2) a minor amount of sediment interlayered with the basalt; and (3) a large thickness of basalt belonging to the Columbia River Basalt Group, which is the most extensive and hydrologically important geologic unit in the aquifer system. (USGS 1999)

The Columbia Plateau aquifer system has been divided into three confining units and four aquifer units. The three confining units are the Saddle Mountains-Wanapum interbed, the Wanapum-Grande Ronde interbed, and the prebasalt rocks. The four aquifer units are the overburden aquifer, the Saddle Mountains unit, the Wanapum unit, and the Grande Ronde unit (USGS 1999). Two of these formations, the Grande Ronde and Wanapum, have been identified within the

Freeman area. The Grande Ronde Basalt Formation is widespread throughout the area (USGS 1994a).

The overburden materials consist of fluvial consolidated to unconsolidated deposits of lacustrine, volcanic, and eolian origin whose lithology ranges from clay to gravels and shale to conglomerate. Most of these deposits generally have a much larger hydraulic conductivity than the basalts and, where saturated, make up a water table aquifer called the overburden aquifer. (USGS 1999)

Water level data from the Columbia Plateau indicate that the vertical flow component is downward over most of the plateau except in discharge areas. These discharge areas are generally in topographic lows. Recharge to the overburden aquifer is mainly from precipitation and from infiltration of applied irrigation water, with discharge to rivers, lakes, drains and waterways, wells, and to the underlying basalt unit. (USGS 1994b)

The Freeman School District well was installed in 1980. According to its well log, the well is 215 feet deep and taps a water bearing zone in quartzite gravel and decomposed granite which is overlain by approximately 145 feet of basalt. Above the basalt is a 46-foot layer of clay. The static water level and presence of a screened interval are not indicated on the well log. The (b) (6) well was installed in 1988 to a depth of 140 feet. According to its well log, this well taps water in “black hard basalt.” The static water level was 78 feet bgs at the time the well was drilled. A screen was not installed. The well log describes the material penetrated as top soil from 0 to 2 feet bgs, yellow clay from 2 to 30 feet bgs, broken basalt from 30 to 44 feet bgs, and basalt from 44 feet bgs to the depth of the well. (WDOH 2013)

A review of 13 well logs believed to be within 1 mile of Freemen School District campus indicate a general geologic pattern of clay from near the ground surface to up to 65 feet bgs, followed by material described as either granite or basalt from the bottom of the clay unit to the depth of the well, although variations from this general pattern occur. Well depths ranged from 100 to 220 feet bgs, though three wells were deeper (i.e., 260, 375, and 560 feet bgs). Only seven of these well logs indicated the depth that water was first encountered. That depth ranged from 49 to 206 feet bgs. Static water levels were reported for all but one well and indicated a range from 29 to 130 feet bgs (WDOH 2013; Ecology 2013b).

GeoEngineers, Inc. conducted a detailed review of well logs within 1 mile of the Freeman School District campus. In total, 34 well logs were examined. GeoEngineers, Inc. determined that wells were generally constructed by placing a steel well casing from the ground surface to roughly 50 to 200 feet bgs to seal off the unconsolidated surficial units. Below the casing, either a liner was present or the well was open to its total depth. Pumping rates ranged from 5 to 120 gallons per minute (gpm), with typical rates between 10 and 30 gpm; however, wells drilled into the basement rock had lower pumping rates and were typically less than 10 gpm. (GeoEngineers 2013)

The direction of ground water flow in the Freeman, Washington area has recently been modeled by GeoEngineers, Inc. This modeling indicated a general flow direction from the northeast to the southwest with a hydraulic gradient in the upper aquifer of approximately $1x10^{-2}$ feet per foot near the Freeman School District campus (GeoEngineers 2013). No wellhead protection areas occur within the 4-mile TDL (SCDBP 2009).

3.1.3 Drinking Water Targets

Approximately 2,369 people use ground water for drinking water purposes within the 4-mile TDL. Drinking water populations by distance ring are provided in Table 3-1. A combination of Group A and Group B community water systems and domestic wells are present. The Washington Administrative Code (WAC) defines the group designation for community water systems. The definitions, as provided by the WDOH, are:

- **Group A:** (WAC 246-290) Group A water systems are those with 15 or more service connections, regardless of the number of people; or systems serving an average of 25 or more people per day for 60 or more days within a calendar year, regardless of the number of service connections. Group A water systems do not include systems serving fewer than 15 single-family residences, regardless of the number of people.

- **Group B:** (WAC 246-291) Group B water systems serve less than 15 residential connections and less than 25 people per day; or 25 or more people per day for fewer than 60 days per year. Group B water systems are those public water systems that do not meet the definition of a Group A water system.

WDOH maintains records of all active public water systems. Public water systems, regardless of group designation, indicate the total number of wells in the system, number of connections, and total population served. A search of the WDOH Sentry Internet database revealed the presence of three Group A community water systems serving a total population of 1,195 people and seven Group B community water systems serving a total population of 39 people (WDOH 2013).

One of the Group A water systems is the Freeman School District system that serves 900 students, teachers, and staff members during the school year which runs from September to June (Leinart 2012). The Freeman School District well serves the elementary, middle, and high schools of the district which are situated in three separate buildings on one campus. The Freeman School District well is the sole source of drinking water to the campus and also is used for fire protection and irrigation (Leinart 2012).

Based on well logs, it is estimated that a total of 469 domestic wells are present within the 4-mile TDL (Ecology 2013b). It is calculated that these wells serve approximately 1,135 people based on the average number of persons per household for Spokane County, Washington of 2.42 people (USCB 2007 to 2011).

Ground water in the area is also used for irrigation of 5 acres or more of commercial food crops.

4 Summary and Conclusions

The Freeman Ground Water Contamination site is a carbon tetrachloride ground water plume that was identified during routine sampling of a Freeman School District well in 2001. At present, a source for this contamination has not been identified.

The town of Freeman has few residences and is dominated by the Freeman School District school campus. The Freeman Store is present on the north end of town. A former Cenex Harvest States store with grain silos and grain elevator is present between State Route 27 and a UPRR line which roughly parallels the highway. A former clay borrow pit is located approximately 0.5 mile northeast of the former Cenex Harvest States store, and a former brick kiln is present on the southern end of town. Beyond these uses, land near Freeman is primarily used for agricultural production.

Carbon tetrachloride has been detected in the primary Freeman School District water supply well at concentrations that exceed the EPA MCL of 5 µg/L on five occasions: April 2008, March 2012, April 2012, December 2012, and January 2013. This well serves approximately 900 students, teachers, and workers. In May 2012, carbon tetrachloride was also identified as being present above the MCL in a newly acquired School District well known as the (b) (6) well; though carbon tetrachloride was not present in this well in later sampling conducted in January 2013 above a detection limit of 1 µg/L. Also, in January 2013, carbon tetrachloride was detected above the MCL in a former residential well located in the southeast portion of the Freeman School District campus. During the January 2013 sampling, chloroform was present in the wells with detectable concentrations of carbon tetrachloride. Chloroform is degradation product of carbon tetrachloride.

A total of 10 community water systems, including the Freeman School District water system, are present within a 4-mile radius of Freeman, Washington, as well as approximately 469 private domestic wells. In total, these wells serve approximately 2,369 people for drinking water purposes. Ground water in the Freeman area is known to occur at depths ranging from 49 to 206 feet bgs based on well logs. The direction of ground water flow is to the southwest.

Carbon tetrachloride was a multi-purpose chemical, used as a degreasing solvent for industrial and domestic purposes, as a fire suppressant, as a cleaning agent for dry cleaning, in making nylon, and for many years was used as a fumigant in grain operations throughout the Midwest. Due to its toxicity, most of these uses were discontinued. Until 1986, the largest source of releases of carbon tetrachloride to the environment was from its use as a grain fumigant.

A potential source of the carbon tetrachloride ground water contamination is the Cenex Harvest States Freeman grain handling facility, though, at present, the use of carbon tetrachloride at this location has not been confirmed. Other, less likely, sources in the area include private grain handling facilities (if present), the UPRR main line and rail siding, the Former Freeman Clay Pit, potential historic use of this chemical at Freeman School District facilities (e.g., welding/metal fabrication and automotive workshops, the school bus service/maintenance shop, and/or laboratory classrooms), a former brick kiln, State Route 27, and former shops and out-buildings associated with the former (b) (6) residence. USTs in the Freeman area have been confirmed to be associated solely with petroleum products and for this reason are not considered to be a potential source of carbon tetrachloride contamination.

Based on the information contained in this PA report, the START recommends that further investigation of this site be conducted under the Comprehensive Environmental Response, Compensation, and Liability Act.

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Figures

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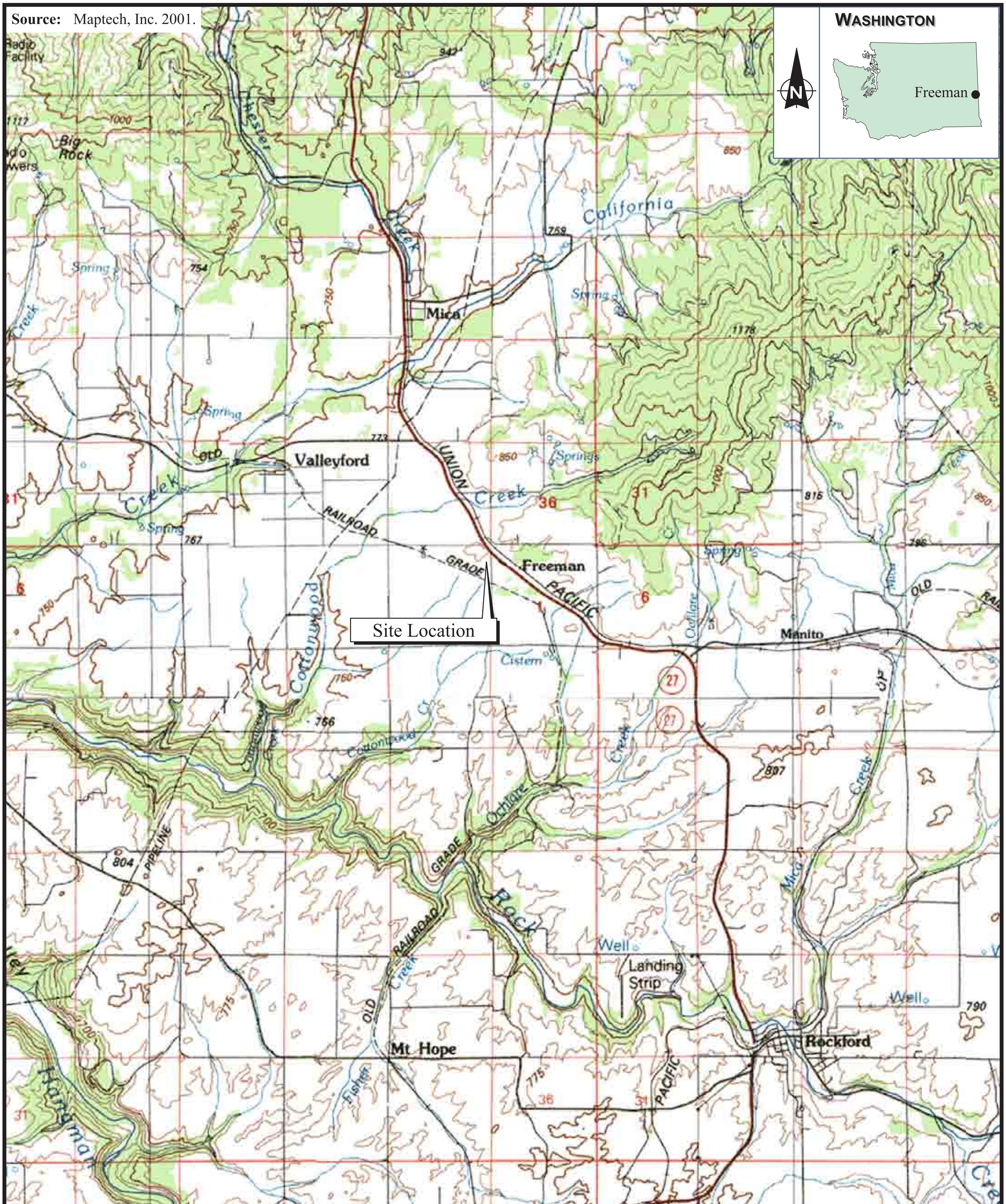

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FREEMAN GROUND WATER CONTAMINATION
Freeman, Washington

0 .5 1
Approximate Scale in Miles

Figure 2-1

SITE VICINITY MAP

Date:	Drawn by:	
3-5-13	AES	10:START-3\12110007\fig 2-1

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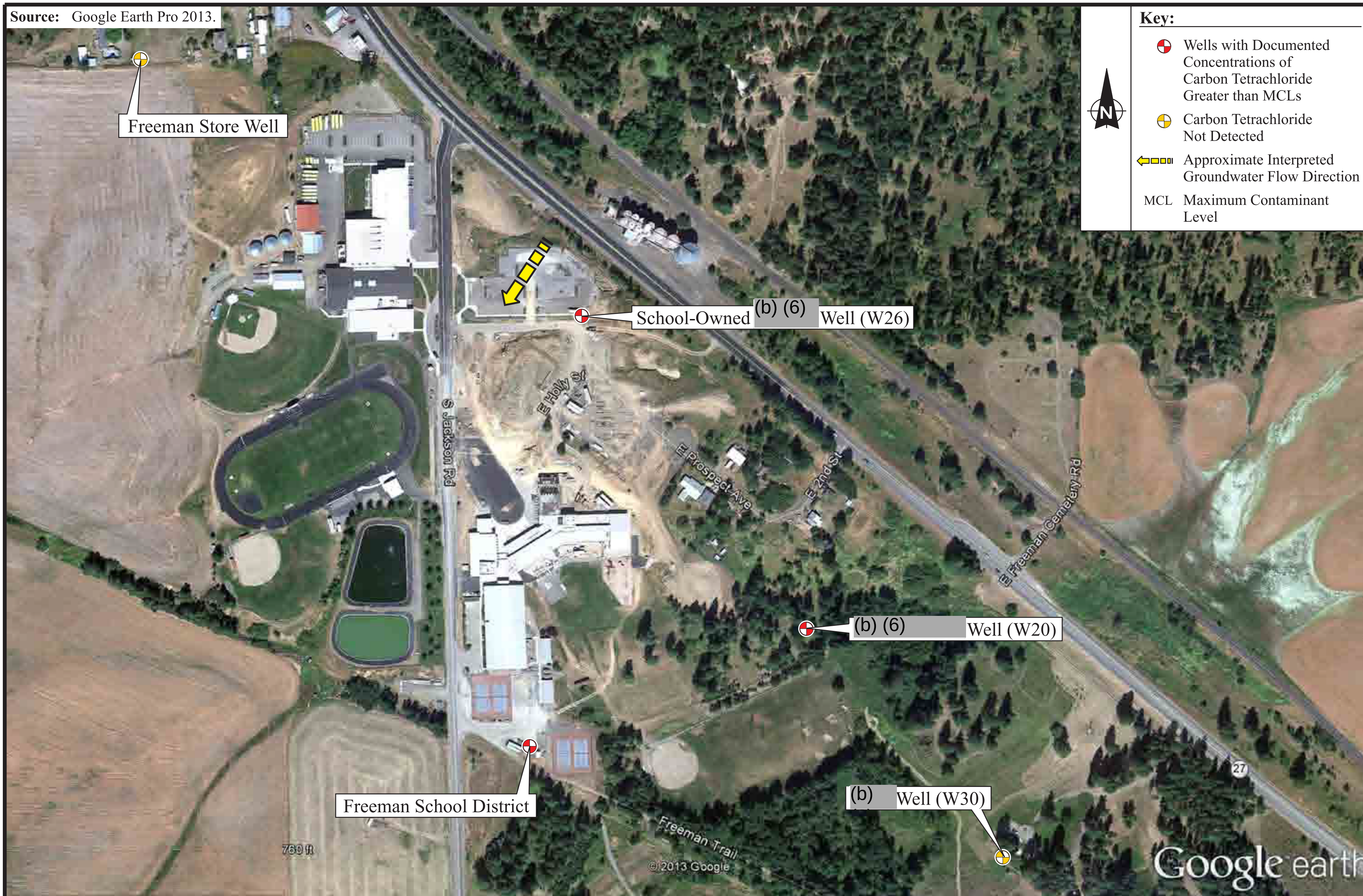
FREEMAN GROUND WATER CONTAMINATION Freeman, Washington	Figure 2-2 SITE MAP		
0 300 600 Approximate Scale in Feet	Date: 3/5/13	Drawn by: AES	10:START-3\12110007\fig 2-2



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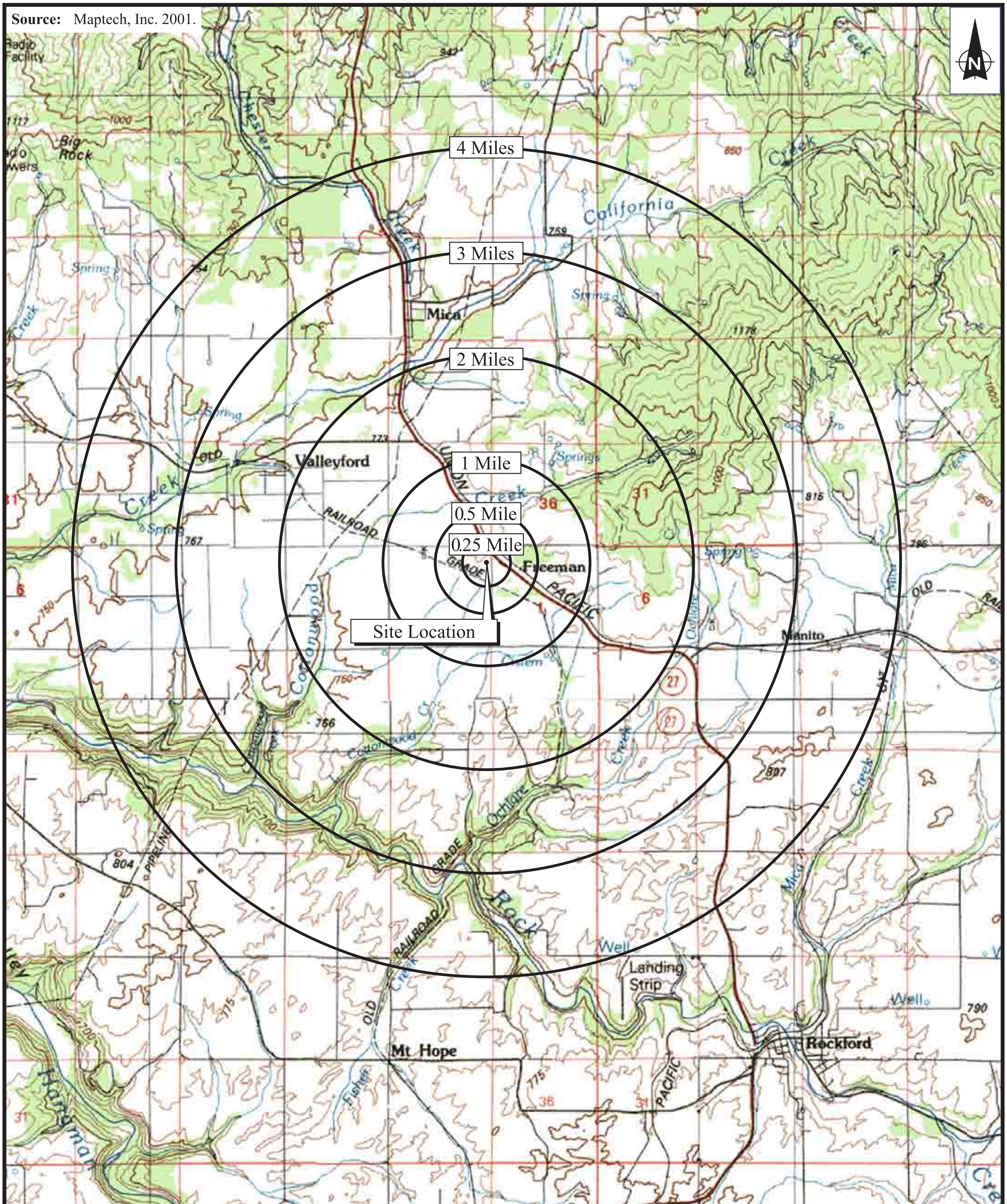
FREEMAN GROUND WATER CONTAMINATION
Freeman, Washington

Figure 2-3
WELLS SAMPLED BY GEOENGINEERS INC. IN JANUARY 2013

0 190 380
Approximate Scale in Feet

Date:	Drawn by:	
3/5/13	AES	10:START-3\12110007\fig 2-3



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FREEMAN GROUND WATER CONTAMINATION
Freeman, Washington

0 .5 1
Approximate Scale in Miles

Figure 3-1

4-MILE TDL MAP

Date:	Drawn by:	
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Tables

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Table 2-1 Freeman School District Drinking Water Well Analytical Results

Sample Date	Analyte	Result (μg/L)
12/12/2012	Carbon Tetrachloride	**8.0 EQ**
9/5/2012	Carbon Tetrachloride	**3.1 EQ**
6/14/2012	Carbon Tetrachloride	**2.1 EQ**
4/19/2012	Carbon Tetrachloride	**7.2 EQ**
3/21/2012	Carbon Tetrachloride	**5.9 EQ**
12/7/2011	Carbon Tetrachloride	0.5 LT
9/21/2011	Carbon Tetrachloride	0.5 LT
6/22/2011	Carbon Tetrachloride	0.5 LT
3/31/2011	Carbon Tetrachloride	**3.9 EQ**
10/27/2010	Carbon Tetrachloride	**3.13 EQ**
8/18/2010	Carbon Tetrachloride	**2.22 EQ**
4/28/2010	Carbon Tetrachloride	**4.29 EQ**
11/4/2009	Carbon Tetrachloride	**3.28 EQ**
6/25/2009	Carbon Tetrachloride	**1.8 EQ**
2/26/2009	Carbon Tetrachloride	**1.66 EQ**
11/13/2008	Carbon Tetrachloride	**3.72 EQ**
9/12/2008	Carbon Tetrachloride	**2.14 EQ**
5/20/2008	Carbon Tetrachloride	**2.34 EQ**
4/3/2008	Carbon Tetrachloride	**7.78 EQ**
4/30/2007	Carbon Tetrachloride	**2.31 EQ**
5/31/2006	Carbon Tetrachloride	0.5 LT
11/16/2004	Carbon Tetrachloride	**1.64 EQ**
8/12/2003	Carbon Tetrachloride	0.5 LT
6/20/2002	Carbon Tetrachloride	**1.4 EQ**
7/11/2001	Carbon Tetrachloride	0.5 LT
3/22/2001	Carbon Tetrachloride	**0.7 EQ**
	Chloroform	**0.7 EQ**
1/30/2001	Carbon Tetrachloride	**0.7 EQ**
11/13/1992	Carbon Tetrachloride	0.5 LT
5/27/1992	Carbon Tetrachloride	0.5 LT

Source: WDOH 2013

Notes:

Bold concentrations indicate the analyte was detected.

Shaded concentrations indicate the value exceeds the EPA Safe Drinking Water Act Maximum Contaminant Level of 5 μg/L.

Key:

EQ = Equal to

LT = Less than

μg/L = micrograms per liter

Table 3-1 Ground Water Drinking Water Population

Distance Ring (miles)	Number of Wells	Well Population	Total Population per Distance Ring
0 - ¼	Domestic - 3	7.26	910.26
	Group A (School District) – 1	900	
	Group B – 1	3	
¼ - ½	Domestic – 6	14.52	14.52
½ - 1	Domestic - 25	60.50	60.50
1 – 2	Domestic – 84	203.28	208.28
	Group B – 1	5	
2 – 3	Domestic - 185	447.70	762.70
	Group A – 2	295	
	Group B – 4	20	
3 – 4	Domestic - 166	401.72	412.72
	Group B – 1	11	
TOTAL			**2,368.98**

Sources: USCB 2007 to 2011; Ecology 2013b; WDOH 2013

Note: Well population was estimated based on the average number of per persons per household for the county in which the well is located. The average population per household for Spokane County, Washington is 2.42.

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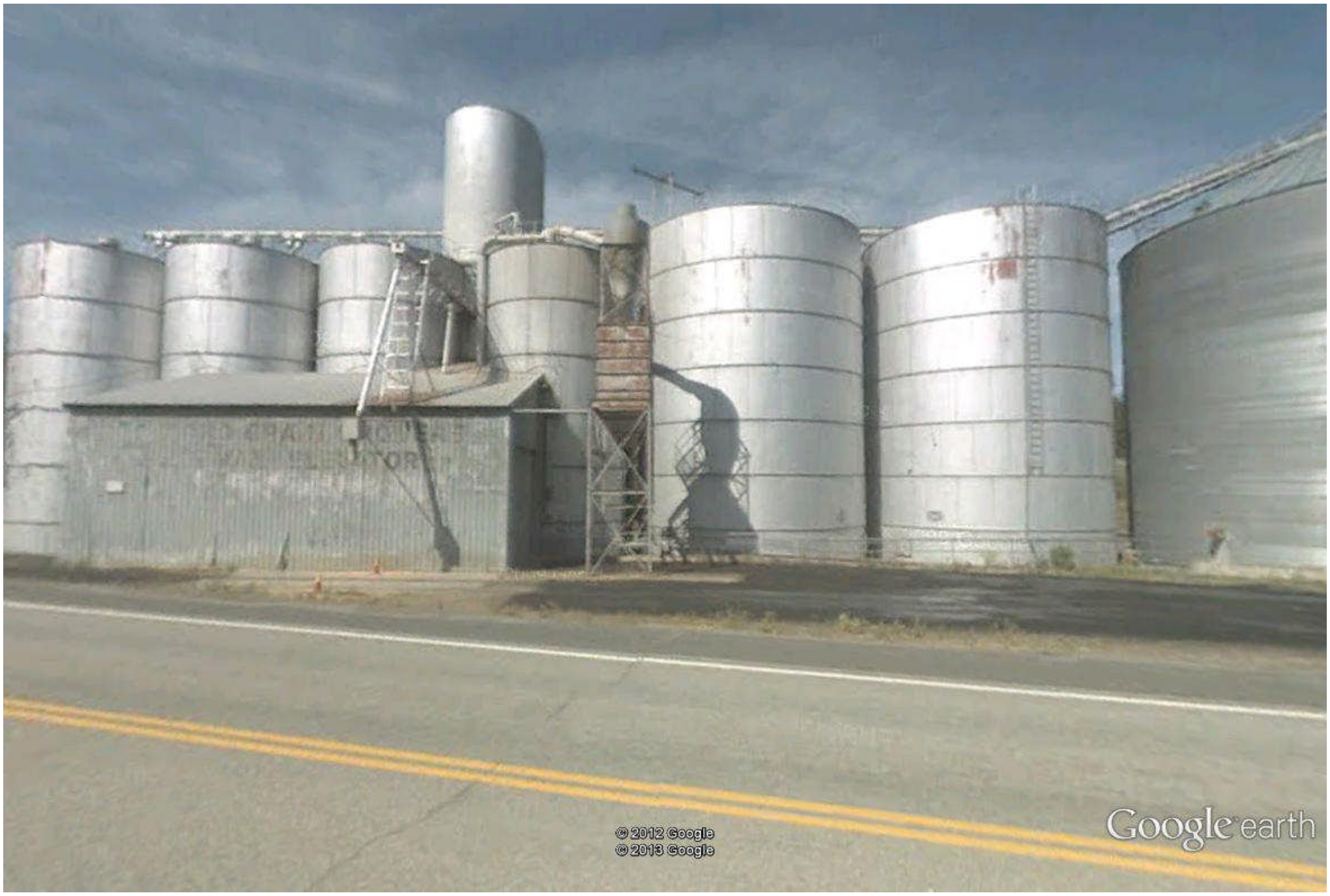

Google earth

feet 10
meters 3

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feet 10
meters 3

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feet 10
meters 3

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